

# Colonization experiment of fungivorous beetles (Ciidae) in a lake-island system

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Direct studies on dispersal of saproxylic insects are generally difficult. I used a field experiment to study the colonization ability of fungivorous beetles in the family Ciidae (Coleoptera). Fruiting bodies of the wood-decaying fungus *Trametes ochracea* (poroid Basidiomycota) were grown on pieces of birch wood in a laboratory. The wood pieces with fruiting bodies were placed out on islets ( $n = 24$ ), as wells as on larger islands and surrounding forests ( $n = 19$ ) of the Lake Koitere in eastern Finland. Islets were situated an average of 658 m from the mainland or larger islands. *Sulcasis affinis* colonized 8%, *Cis hispidus* 75%, *C. boleti* 21% and *Octotemnus glabriculus* 8% of the fruiting bodies on the islets. These results suggest that the colonization ability of the ciid beetles is rather good (up to 1.5 km), but there are considerable differences between species. The observed differences in colonization pattern may be related to species preferences regarding the sun-exposure of the substrate.

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## Introduction

Knowledge on dispersal ability of species is important to understand species spatial dynamics and assess the effects of habitat loss and fragmentation on population persistence. Dispersal ability of saproxylic (dead-wood dependent) species is generally poorly known, although it is likely to correlate with the habitat predictability (Southwood 1977). Many bark beetle and fire-adapted species are known to be good dispersers (Forsse & Solbreck 1985, Wikars 1997), whilst species in more stable substrates (e.g. in tree hollows) seem to have low dispersal rates (Nilsson & Baranowski 1997). Fungivorous beetles are likely to fall between these two extremes in terms of their dispersal ability.

Dispersal can be studied using several methods. Direct methods include marking and recapturing individuals, which is a suitable technique for species which are easy to detect, collect and

mark, such as butterflies (Wahlberg et al. 2002). Species dispersal has also been studied in flight-mill experiments (Jonsson 2003), but it is difficult to draw conclusions about species behavior in nature from such laboratory experiments. Indirect studies of dispersal ability have been more common. These include linking of species occurrence on isolated resource patches statistically with patch isolation (Driscoll 2007). Inferences about species dispersal ability can also be done using the level of genetic variation as an indication of spatial isolation of populations (Roslin 2001).

One easy way to estimate dispersal distances and colonization ability is to place suitable resources in places where the closest possible origin of colonizers is known. Nuorteva & Nuorteva (1968) placed freshly cut timber on islands in archipelago and observed the colonization of bark beetles and their parasitoids. Jonsell et al. (1999)



Figure 1. Pieces of birch wood with *Trametes ochracea* fruiting bodies were placed out on islets to study the colonization ability of fungivorous beetles.

Björkved med zonticka (*Trametes ochracea*) placerades ut på små skär för att studera kolonisationsförmågan hos ticklevande skalbaggar.



placed fruiting bodies of the wood-decaying fungi *Fomitopsis pinicola* and *Fomes fomentarius* on forest stands surrounded by open fields. The fruiting bodies had been frozen in -60°C to kill all the insects that possibly were present inside the fruiting bodies. As many ciid beetle species use host odours to locate suitable breeding substrate (Jonsell & Nordlander 1995), the removal of fruiting bodies from the wood might have affected the attractability of the fruiting bodies.

*Trametes ochracea* (Pers.) Gilb. & Ryvarden (poroid Basidiomycota) is an annual polyporous fungus, which grows on many broadleaved tree species, particularly on birch and aspen. It is an abundant species in all successional stages of forests and occurs on snags, logs, stumps as well as on logging residues. In this study, fruit-

Figure 2. Study area in the Lake Koitere in eastern Finland. The largest islands are shown with dark grey. Black circles indicate the islet and mainland samples.

Studieområdet i Koitere sjö, östra Finland. De största öarna markeras med mörkgrått, de svarta cirklarna indikerar de utplacerade proverna på skär och i kontrollområden.

ing bodies of *T. ochracea* were grown on pieces of birch wood in a laboratory. The wood pieces with fruiting bodies were placed out on small islets, as well as on larger islands and surrounding mainland forests of the Lake Koitere in eastern Finland (Fig. 1). Here I report on the colonization patterns of four fungivorous beetles in the family Ciidae: *Sulcasis affinis* (Gyllenhal, 1827), *Cis hispidus* (Paykull, 1798), *Cis boleti* (Scopoli, 1763) and *Octotemnus glabriculus* (Gyllenhal, 1827). All these species are specialists on wood-decaying fungi and complete their development inside the fruiting bodies. *Cis hispidus*, *C. boleti* and *O. glabriculus* show strong preference towards *Trametes*, but *S. affinis* also occurs in high numbers in *Pycnoporus cinnabarinus* (Økland 1995), which is taxonomically close to *Trametes*.

## Materials & methods

Living *T. ochracea* fruiting bodies were collected from the field. To grow fungal mycelium, pieces of spore surface were transferred to agar. When we saw that the mycelia started to grow, the mycelia were transferred to pieces of birch wood, which were 15–25 cm long and 4–8 cm in diameter. The wood pieces were enclosed in plastic bags to enhance mycelial growth. After the mycelia had covered almost all of the wood pieces, they were transferred to growth chambers and grown under typical late summer–early autumn conditions in terms of moisture, temperature and light conditions from August 2003 to May 2004. All wood pieces were kept under the same conditions, but we varied the moisture, temperature and light conditions over time, as we did not know the best conditions for the fruiting body production. Details about the laboratory procedure are available from the author upon request.

The colonization experiment was conducted on the Lake Koitere (62°58' N, 30°46' E) in eastern Finland between 4 June – 27 September 2004 (Fig. 2). The surface area of the lake is 167 km<sup>2</sup>. The wood pieces with fruiting bodies were placed out on small islets ( $n = 24$ ), as wells as on larger islands and surrounding mainland forests ( $n = 19$ ). There are three large islands (roughly 2–4 square km in area) in the middle of

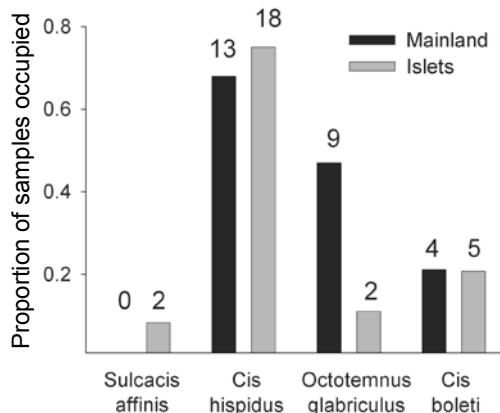


Figure 3. Frequency of occurrence of four ciid beetles in the fruiting bodies placed out on islets ( $n = 24$ ) and on mainland and larger islands ( $n = 19$ ). Figures above the bars give the number of occupied samples.

Kolonisationsfrekvens för fyra trädsvampborrare (Ciidae) i fruktkroppar på skär ( $n = 24$ ), och i kontrollområden ( $n = 19$ , större ör och skogar) omkring Koitere sjö. Siffrorna över stolarna visar antalet koloniserade pröver.

the lake, and these are likely to host permanent *Trametes* populations. Although there is no specific information on *Trametes* abundance on the larger islands or on the mainland, the species is generally known to be common in the region, particularly in areas where there are plenty of broadleaved trees.

On each islet, one piece of wood was placed out in sun-exposed conditions (Fig. 1). All islets were devoid of other polypore fruiting bodies. On larger islands and mainland, the wood pieces were placed out in pairs (except three in one site) separated by ca. 100 m and were all in shady conditions. The average nearest neighbor distance from the islets to a mainland or larger island was 652 m (SD = 345, range 170–1560 m). After the field season, the fruiting bodies were transferred to a laboratory to rear out the insects living inside. The insects were collected from the rearing sacks in winter 2005.

## Results

*Sulcasis affinis* colonized 8% (2 beetle individuals), *C. hispidus* 75% (228 indiv.), *C. bo-*

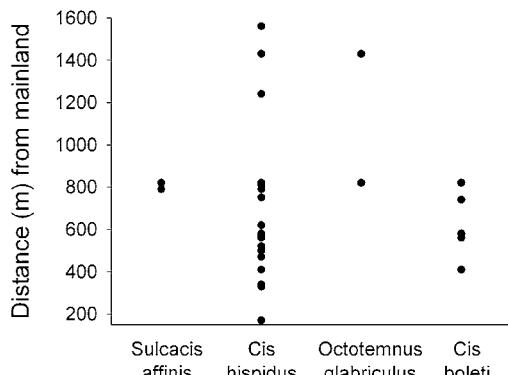


Figure 4. Distances of colonized islets from mainland and larger islands for the four ciid beetles.

Avstånd från kontrollområden till de koloniserade proverna på skär för fyra trädsvampborrare (Ciidae).

*leti* 21% (20 indiv.) and *O. glabriculus* 8% (7 indiv.) of the fruiting bodies on the islets (Fig. 3). *Sulcasis affinis* and *C. hispidus* were more frequent in fruiting bodies on the islets than on the mainland, whereas *O. glabriculus* was more frequent on the mainland. The difference in the frequency of occurrence was statistically significant only for *O. glabriculus* ( $\chi^2 = 8.49$ ,  $df = 1$ ,  $p = 0.005$ ). *Cis boleti* had an equal frequency of occurrence on the islets and mainland. There was no relationship between the number of *C. hispidus* individuals in a given islet sample and the distance from mainland ( $r_p = -0.09$ ,  $n = 24$ ,  $p = 0.67$ ). The observed colonization distances are shown in Fig. 4.

## Discussion

My results suggest that the colonization ability of the fungivorous ciid beetles is rather good (up to 1.5 km), but there are considerable differences between species. The difference between species does not necessarily reflect differences in species dispersal ability per se. Rather it may result from species willingness to cross open areas and colonize fruiting bodies on sun-exposed islets. The two species (*S. affinis* and *C. hispidus*) that were more frequent on the sun-exposed islets than on the shady mainland sites

are known to be associated with sun-exposed substrates (Fossli & Andersen 1998, Komonen & Kouki 2005, Lindhe et al. 2005). The other two species (*O. glabriculus* and *C. boleti*) that were equally or more frequent on the mainland samples are known to be associated more often with shady substrates (Fossli & Andersen 1998, Sverdrup-Thygeson & Ims 2002, Komonen & Kouki 2005, Lindhe et al. 2005).

Jonsell et al. (1999) found out that the ciid beetles *Cis glabratus* and *C. quadridens* were absent from *F. pinicola* fruiting bodies placed 150 to 500 m from the nearest forest stand. A larger beetle species *Dorcatoma punctulata*, on the other hand, was able to colonize the isolated fruiting bodies. Furthermore, *C. hispidus* and *C. boleti* have been found to be the most common ciid species in unbaited window traps (Siitonens 1994, Jonsell & Nordlander 1995). One could thus speculate that the somewhat higher movement rate and better colonization ability of the ciids associated with annual *Trametes* fruiting bodies – in comparison with the ciids associated with perennial *F. pinicola* fruiting bodies – is linked with the predictability of the substrate (Southwood 1977). On the other hand, although the individual fruiting bodies of *Trametes* fungi have short durational stability (ca. one year), there is often local continuity of fruiting bodies, so there is not necessarily stronger selection on dispersal ability of *Trametes*-dwelling species. It is yet difficult to draw definite conclusions from small-scale case studies that have applied different research protocols.

Although this study shows that ciid beetles can colonize substrate patches over relatively large distances and over truly hostile matrix (water), the study cannot answer what is the typical dispersal distance of these beetles. As dispersal is one of the most important, yet least known factors influencing species spatial dynamics, more studies are clearly needed. Placing artificially created substrate patches in different landscapes is one potential way to study dispersal and colonization ability of many species. Experimental field studies using artificially created substrate patches can also be used to answer many other ecological questions, such as questions about species interactions and habitat selection.

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## Sammanfattning

Direkta studier av spridningsförmåga hos vedlevande insekter är svåra att genomföra. Samtidigt är kunskap om spridningsförmågan central då man vill bedöma arters förmåga att överleva i ett förändrat landskap. Jag gjorde därför ett fältexperiment för att studera hur skalbaggar av familjen Ciidae (trädstampborrare) koloniserade små skär i en sjö. Fruktkroppar av zontickan (*Trametes ochracea*) (poroid Basidiomycota) odlades fram på björkved i laboratorium. Fruktkropparna placerades ut på skär ( $n = 24$ ), och på större öar och i skogar ( $n = 19$ ) vid Koitere sjö i östra Finland. *Sulcatis affinis* koloniserade 8%, *C. hispidus* 75%, *C. boleti* 21% och *O. glabriculus* 8% av fruktropparna på skären. Resultaten visar att trädstampborrarnas förmåga att kolonisera nya platser är god (upp till 1,5 km), men det finns betydande skillnader mellan arter. Det är möjligt att de observerade skillnaderna beror på arternas preferenser när det gäller substratets solexponering.